DOCUMENT RESUME

ED 285 525 IR 012 730

AUTHOR Aust, Ronald J.
TITLE Introverted Approaches to Instructional Media Research: Eliciting Perceptual Processes Which Contribute to Learning.
PUB DATE Feb 87
NOTE 20p.; Paper presented at the Annual Convention of the Association for Educational Communications and Technology (Atlanta, GA, February 26-March 1, 1987). For the complete proceedings, see IR 012 723.
PUB TYPE Information Analyses (070) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Epistemology; Literature Reviews; *Media Research; *Perception; Perception Tests; Perceptual Development; Psychological Studies; Research Needs
IDENTIFIERS AECT Research and Theory Division Meeting

ABSTRACT

Meanings given to the term "perception" are discussed in this paper and two categories of perception theories having implications for instructional media research are identified. One category is described as extroverted because it includes theories primarily concerned with characteristics of external stimuli and the influence that the corresponding information has on the formation of mental representations or percepts. Described as introverted, the second category of perception theories is concerned with the self-directed internal processes that individuals use in constructing percepts from sensory information. Research based on both theories of perception is reviewed as well as the literatures on (1) the ability to mentally construct or transform memorial representations and on (2) the validation of perceptual processes. Several questions for further research are outlined. A figure showing the use of anorthscopic perception (i.e., the ability to recognize figures as they pass behind a narrow slit which is oriented vertically in the center of a stationary opaque field) to validate central mechanisms of perception is included and 64 references are listed. (MES)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED285525

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Title:

Introverted Approaches to Instructional Media Research: Eliciting Perceptual Processes Which Contribute to Learning

Author:

Ronald J. Aust

IR012730

BEST COPY AVAILABLE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Michael R. Simonson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Introverted Approaches to Instructional Media Research: Eliciting Perceptual Processes Which Contribute to Learning

Ronald J. Aust
University of Kansas

Instructional Technology Center
Bailey Annex
University of Kansas
Lawrence, Kansas 66045
(913) 864-3057

Introverted Approaches to Instructional Media Research: Eliciting Perceptual Processes Which Contribute to Learning

Ronald J. Aust
University of Kansas

Instructional media researchers have often adopted theories of perception as conceptual guides for conducting research. Norberg (1953, 1962, 1966, 1978) identified two categories of perception theories and contended that each had distinct implications for instructional media research. One category is described as extroverted because it includes theories which are primarily concerned with characteristics of external stimuli and the influence that the corresponding sensory information has on the formation of mental representations or percepts. Extroverted theories assert that the meanings individuals draw from sensory information are primarily determined by the quality of the stimuli; inferring that the perceiver is relatively passive in perception. The other category of perception theories is described as introverted. Supporters of introverted theories believe that the most compelling aspects of perception are the self-directed internal processes that individuals use in constructing percepts from sensory information.

Assumptions underlying extroverted and introverted theories of perception have alternate implications for instructional media research. By emphasizing the importance of stimulus quality, extroverted theories imply that instructional media research should center on characteristics of mediated stimuli. These stimulus based approaches include: methods for making distinctions between "real world" and mediated stimuli, schemes for classifying differences in mediated stimuli and strategies for determining the amount and quality of stimuli which will optimize the understanding of specific concepts. Introverted theories presume that the individual is actively involved in the construction of percepts, implying that research should focus on media strategies for developing, enhancing, or eliciting internal perceptual processes which contribute to intelligence.

Much of the instructional media research and many of the media utilization models (Dale, 1969; Dwyer, 1970) and message design principles (see Fleming & Levie, 1978) have been based on extroverted theories of perception. However, despite Norberg's (1966, 1978) recommendations for pursuing research based on introverted theories, few such studies have been conducted. A comprehensive plan for conducting

research based on introverted theories is needed. Moreover, this plan should lead to media strategies for establishing or eliciting perceptual processes which contribute to intelligence, as opposed to being concerned primarily with the acquisition of specific facts or concepts.

Perception: A Relevant Definition for Instructional Media Research

Before considering theories of perception in greater detail it is appropriate to define, or at least limit the meanings given to, the term perception. Debates regarding the nature of perception have crossed a wide range of disciplines including: art, education, engineering, philosophy and psychology. Lebowitz (1965) explained that this wide-spread interest has not yielded a universal definition, and suggested that interpretations be guided, to some extent, by the practical and theoretical needs of the users. The definition for perception, adopted by instructional media researchers, should: accord relevant means for identifying the primary mental processes under investigation, recognize possible contributions of affiliated processes, and provide a framework for determining how media can be used to promote the acquisition of mental processing skills.

Psychologists, Brown and Deffenbacher (1979) refered to physical world phenomena in terms of distal and proximal stimuli. Objects and events in the physical world are referred to as distal stimuli. Information about the distal stimuli which reaches the senses is called proximal stimuli, which may be in the form of light energy, sound waves, chemical molecules, heat, or pressure. In vision, the proximal stimuli emanating from an object takes the form of distinctive diffraction patterns of light energy. These distinctive diffraction patterns serve as an encoded representation of the object. When the encoded light energy strikes the viewer's eye, it cause a change in the firing rate of the receptor cells in retina. These initial sensory reactions to proximal stimuli are called sensation.

As sensory messages travel along the neural pathways to various locations in the brain, neural mechanisms alter the structure of the information prior to the formation of the percept (Cornsweet, 1970; Hubel & Wiesel, 1977). The mental development of the percept is further influenced by central mechanisms responsible for attending to and selecting certain aspects of the sensory information. These mechanisms also include constructive processes used in deriving meaning from sensory arrays (Gregory 1970; Gyr, 1972; Rock, 1983).

A complete description of perception includes both processes involved in sensation and central processes which may not require the direct input of sensory information.

As a long-standing precedence, psychologists (James, 1890; Wundt, 1970; Hillgard, Atkinson & Atkinson, 1971) have chosen to define perception in terms of conscious mental representations that have an immediate relationship to the proximal stimuli. Thus, perception is defined as, "The mental processes used in developing conscious percepts which are the immediate result of sensation." This definition makes a distinction between perceptual processes and higher-order cognitive processes used in the formation or manipulation of memorial representations. However, perception is also considered to be a subset of cognition; with perceptual processes having a reciprocal interaction with higher-order cognitive processes including hypothesis formation and problem solving (Neisser, 1966).

A definition for perception, that distinguishes between those mental processes which result in the formation of percepts and those which result in the formation of memorial representations, may serve as a guide for instructional media researchers. According to this definition a number of percepts might be formed while visiting the zoo, watching a film or reading a book. But the mental representations which remain once the individual has left the zoo, finished viewing Fantasia, or reading The Wizard of Oz, are formed by higher-order cognitive, as opposed to strictly perceptual processes. This is because the memorial representations are acted upon in absence of the corresponding sensory information. The memorial representation may be in the form of images which possess perceptual-like qualities (Shepard & Podgorny, 1978; Cooper & Shepard, 1970; Fleming, 1977), but the processes acting on their construction may also have some distinct differences which impact on learning (Richardson, 1969; Kosslyn & Pomerantz, 1977; Paivio, 1976). Thus, the distinction between percepts and images, and the corresponding processes used in their construction, might aid in the identification of media strategies for effecting the transfer of perceptual processes to higher-order cognitive processes affiliated with intelligence.

Research Based on Extroverted Theories of Perception

According to Gibson (1954, 1966, 1972), movement through the environment is the enablihg factor in perception. Gibson claimed that as individuals moves through the environment they become aware of the invariant qualities of objects. The ability to differentiate objects is developed as perceivers begin to make associations between invariant qualities and the objects they represent.

Exposure to a wide variety of environmental stimuli has the more far-reaching effect of providing the learner with the basis for developing abilities to absorb invariant qualities more readily.

In his recommendations to media researchers, Gibson (1954) noted that media provide the means for exposing learners to an extensive variety of artificial or vicarious experiences which they may not otherwise have the opportunity to encounter. However, he stressed that the effectiveness of instruction with media is highly dependent on the nature of the media stimuli or surrogates employed. Gibson (1954) defined surrogate as "a stimulus produced by an individual which is relatively specific to some object, place or event not at present affecting the sense organ of the perceiving individual" (p.5).

Gibson identified two forms of surrogates; conventional and non-conventional. Conventional surrogates, such as words or numbers, are connected to their referents by conventions of arbitrary rules established by society. Non-conventional surrogates are replicative. In other words, the information projected by non-conventional surrogates is isomorphic to the information which would have been projected by its referent. Drawings, photographs and films are forms of non-conventional surrogates; although they vary in the degree to which the are replicative.

Extroverted theories which focus on the importance of invariant qualities and distinctive features (Travers, 1977) of stimuli have led to a number of schemata for classifying media attributes. The more recent schemata articulate distinctions which are similar to those made by Gibson in differentiating conventional and non-conventional surrogates. Kennedy (1974) and Levie (1978) referred to words and numbers as non-iconic symbols while drawings and photographs are described as iconic symbols. Other researchers (Olson & Bruner 1974; Salomon 1977), have recommended employing Goodman's (1968) notation scheme for determining relationships between media attributes and mental processes. While Goodman's scheme may provide greater differentiation between symbol systems, the essential distinction between verbal type and pictorial type systems is similar the distinction proposed by Gibson.

In Goodman's classification scheme, notational symbol systems, such as verbal language, numbers and music, are characterized by arbitrary conventions of syntax and semantics. More notational systems establish more precise connections between symbols and referents. Thus, highly notational symbol systems require the learner to develop precise associations between the symbol and its referent. On the other hand, non-notational symbol systems, project the essential proximal stimuli that would have been projected by the referents. This isomorphism between symbol

and referent, characteristic of highly non-notational systems, allows learners to gain meaning through basic perceptual processes used to interpret the external world.

The assumptions regarding how people learn from notational and non-notational symbol systems have implications for instructional media research which are characteristic of extroverted approaches to perception. Instruction with highly notational symbol systems requires that the learner possess a thorough understanding of the syntax and semantic of the system before learning can take place. Instruction with highly non-notational symbol systems relies on the learners' "natural" ability to mediate the invariant qualities in sensory information. This implies that message designer's should be aware of the invariant qualities implicit in non-notational symbols and base instructional design on principles which govern their structure.

Extroverted theories have provided insights for designing messages which exploit existing mental processes to teach specific concepts (Fleming & Levie, 1984). Nonetheless, they are not particularly useful when the goal is to develop or elicit perceptual processes. There is evidence that perceptual experience is required during the early critical phases of development in order to establish normal perceptual abilities (Blakemore & Cooper, 1970; Gregory, 1977). However, the basic perceptual processes, required to recognize invariant qualities, appear to develop naturally during the course of normal humans development (Hochberg & Brooks, 1962; Movshon & Van Slyter, 1981). Introverted theories may provide a more fruitful basis for relating perception to learning because they assume that the learner is actively involved in the construction of percepts. As Norberg (1978) explained. "If perception is regarded as a constructive process, in some degree an interpretation of the `outside' world, and not just a direct apprehension of some preexistent reality, it then becomes reasonable to inquire into the means by which perceptual judgements are formed" (p.9).

Research Based on Introverted Theories of Perception

The principles developed by the Gestalt psychologists (Wertheimer, 1923; Kőffka, 1935; Kőhler, 1947) represent some of the basic assumptions of introverted theories of perception. Gestalt psychologists believed that perception is dictated by a mental tendency toward consistency. They used the term "Prägnanz" to describe this tendency; which has the rather vague meaning of wholeness, good, simple or regular, depending on the application. Employing a number of

specifically designed drawings and objects, the Gestalt psychologists conducted experiments to identify certain principles which influence Prägnanz. These principles included tendencies to: associate parts of drawings with either a figure or ground, group adjacent parts of figures together, group similarly shaped parts together, and see continuation in broken lines. The Gestalt psychologists concluded that perception is guided by automatic or spontaneous principles of Prägnanz which transcend stimulus characteristics.

More recent introverted theories agree with the Gestalt assumption that the construction of the percept is to a large extent dependent on the nature of internal processing skills. However, they disagree with the assumption that these processes are spontaneous. Gregory (1970) and Rock (1975, 1983) believe that central mechanisms of perception often involve decision-making processes which incorporate analysis by the perceiver. For example, Rock (1975) proposed that during resolution of figure-ground problems the stimulus information is first registered centrally. This central representation is then analyzed by hypothesis forming mechanisms which take into account the possibility that the contour represents either the figure or the ground. The percept is then formed according to the most plausible solution. He further explained that reversal of percepts, which occurs when viewing ambiguous figures, such as Rubin's Greek Urn, is a reflection of the central mechanism's attempt to solve equally plausible solutions. This explanation for resolving ambiguous figures differs greatly from the one offered by the Gestalt psychologist, Köhler (1947), who explained that such reversals are spontaneously induced after a sort of neural fatigue sets in.

According to Rock's explanation, many of the central mechanisms of perception resemble processes, including problem solving, probability judgements and hypothesis testing, which are affiliated with intelligence. Because they must operate on sensory information prior to the formation of conscious percepts, these cognitive-like central mechanism of perception may serve as precursors to higher-order processes used in manipulating images. Neisser (1966) contended that perceptual anticipatory schemata influence what information is acquired, and this new information in turn modifies cognitive schemata. When new information cannot be accommodated by existing cognitive schemata, the structure of the schemata must be transformed before the new information can be absorbed (Flavell, 1977, 1979; Salomon, 1981). If the learner can be prompted to activates perceptual mechanisms which have sufficient resemblance to cognitive schemata capable of accommodating this new information, the perceptional mechanism may provide the necessary framework for accommodating the new information.

The notion that higher-order cognitive processes are somewhat dependent on the development of perceptual processes is expressed in Piaget's (1966a; 1966b) genetic epistemology theory. Piaget explained that during the preoperational stage (ages 2-7), children are egocentric in their thinking. That is, they are primarily concerned with their subjective relationship to objects and events. Preoperational children tend to concentrate on particular aspects (centration) and, for the most part, fail to integrate or reconstruct parts into meaningful wholes. They begin to use verbal and iconic symbology but are often incapable of understanding relationships, such as reversibility, that are implied by the syntax in language.

As children enter the concrete operational stage, (ages 7-11) they become more objective in their thinking. Their thought is characterized by logic and the ability to understand relationships such as reversibility. Their perception of objects also becomes more objective as they begin to move their focus away from particular details (decenter) and mediate transformational relationships. Piaget and Inhelder (1971) explain this change, from centering on particular details to a more objective view of parts relationships, in conclusions drawn from experiments with the conservation of liquid task. Preoperational children do not realize that when a fixed volume of liquid is transferred from a narrow glass to a wide glass the height of the liquid will change. This is because they center on a particular perceptual aspect, e.g., the height of the liquid. On the other hand, operational children can anticipate the change accurately because they are capable of mentally transforming the various perceptual aspects.

The conservation of liquid problem involves processes which can transform both percepts and images. Piaget believed that the ability to make the necessary mental transformation is, to a great degree, affected by the child's stage of development. But he also believed that transformational imagery processes are contingent on the child's previous exposure to, and ability in, processing similar perceptual transformations. Piaget (1966a) stated, "It is of great interest to find this event of decentration occurring at the perceptual level, because it appears in one form or another as a necessary condition for cognitive adaptation at all levels of the elaboration of knowledge" p. (365).

The assumption that perceptual processes lead to higher-order cognitive processes implies that media strategies could be designed to replicate processing skills with external media techniques. This is the proposition that Salomon (1979) used in designing research to investigate the ability of media attributes to model mental processes used in cue-attendance. Salomon conducted a study in which the zooming attribute of a camera lens was designed to supplant the mental zooming that was supposedly employed by

individuals accomplished in attending to pictorial cues. He found that the zooming instruction aided subjects who initially scored low on the cue-attendance task but deterred high-initial-scorers. Apparently, the zooming instruction interfered with the functional cue-attending strategies employed by those who are good at attending to pictorial cues.

Salomon offered an innovative approach to developing mental skills with media. However, the interactions between supplantation method and aptitude points to a conceptual flaw in Salomon's agenda for research. Mental processes cannot be observed directly, they can only be inferred from behavior. If the exact nature of the target processes is unknown, it is not possible to replicate processes with media attributes. Furthermore, as the numerous Trait-Treatment Interaction studies have found, different mental processes are often used to accomplish the same task (Cronbach & Snow, 1977; DiVesta, 1975; Heidt, 1978). Adopting strategies for supplanting specific processes for specific tasks invites Orwellian uniformity in thinking without providing evidence that the supplanted processes will be accommodated by the learner's cognitive structure. A more appropriate approach is to assume that the seed of ingenuity resides within the learner and devise strategies for eliciting, instead of replicating, mental processes.

Like other process oriented research, investigations of strategies for eliciting central mechanisms of perception should provide evidence that the addressed mental process have cognitive validity. Sternberg (1983) pointed out that many of the errors which have plagued intellectual skills training programs could be avoided by establishing theories of intellectual performance which specify mental processes that have received verification outside the context of the training programs. Since a comprehensive training program involves training in several processing skills, each of the processes must be validated independently. The strategies can then be incorporated in an intellectual training program designed to address one intellectual component consisting of a number of related mental processes. The processes which fall under the general intellectual component of mental imagery are promising candidates for research investigating strategies for eliciting central mechanisms of perception.

Constructive and Transformational Imagery: Contributions to Intelligence

The ability to mentally manipulate perceptual-like or analog mental images has been linked to development of memory (Paivio, 1976; Bower, 1972), reasoning skills (Piaget & Inhelder, 1971; Bruner, Olver & Greenfield 1966; Kaufmann 1979) and creative thinking (Shepard 1978; Hadamard, 1945; Finke, 1980). The imagery process implicated in these

studies require the ability to either mentally construct and/or transform memorial representations. Evidence supporting the validity of these constructive and transformational imagery processes is found in psycho-biographical reports on noted thinkers (Hadamard, 1945; Shepard, 1978). Of particular interest are reports from James Maxwell on the mental processes he used while developing theories of electromagnetic radiation and by Albert Einstein on his thoughts during the development of the "Special Theory of Relativity." Both Maxwell and Einstein reported constructing and transforming images of three-dimensional physical bodies. Shepard explained that Einstein initially conceived the "Special Theory of Relativity" while imagining himself traveling at the speed of light and noting what he "observed" did not correspond to existing theories. Such imaging skills require highly abstracted yet well organized mental processes capable of constructing mental representations based on the integration of both spatial and temporal dimensions.

Validating Imagery Processes and Corresponding Central Mechanisms of Perception

Butterfield, Silida and Belmont (1980) recommended using a developmental approach to validate processes involved in intelligence. They defined process as "any aspect of cognition that changes with age or can be changed by experience" (96). Processes involved in intelligence are considered to be those that become increasingly complex and abstractly organized with age. The existence of standardized tests of intelligence which incorporate age variables is offered as evidence for the broad acceptance of this assumption.

A study of anorthscopic perceptual processes conducted by Aust (1984) provides an example of how the developmental approach can be used to validate central mechanisms of perception. Anorthscopic (abnormally viewed) perception refers to the ability to recognize figures as they pass behind a narrow slit which is oriented vertically in the center of a stationary opaque field. Recognition of anorthscopically presented figures requires the mental construction of figure percepts on the basis of spatial and temporal information. Since both the viewer and the display positions remain constant, the proximal information from the slit falls in a fixed location on the viewer's retina. Consequently, the two-dimensional properties of the figures must be constructed on the basis of changes which occur only along the slit. The processes used to mentally construct percepts from an anorthscopic display are described as perceptual because they are connected directly to proximal

stimuli, as opposed to being constructed from memorial representations. Rock (1975) reported that viewers of anorthscopic displays form conscious percepts of the figures. That is, they report "seeing" faint copies of the figures while viewing anorthscopic displays.

Subjects were 20 kindergartners, 20 second graders, and 20 adult undergraduate students. Anorthscopic displays of eight familiar and eight unfamiliar figures were prepared and transferred in a random order to videotape (see figure 1 for examples). Subjects were individually tested by an observer in a distraction-free room where they sat in front of a television monitor. After each figure had passed the slit on the television monitor the observer stopped the videotape and asked the subject to point to one of 16 figures printed on a form. This forced-choice measure of recognition ability served as the dependent variable.

Analysis of recognition ability found that adults ($\underline{M}$= 15.5) recognized more figures than second graders ($\underline{M}$= 14.5), who recognized more figures than kindergartners ($\underline{M}$= 11.4). Scheffe analysis at the .05 level found a significant difference between subset one, comprised of kindergartners, and subset two, comprised of adults and second graders. Results confirmed the hypotheses that the ability to process anorthscopically presented information follows a developmental trend similar to Piagetian operations of intelligence.

A second aspect of the anorthscopic perception study investigated the effects of temporal components on the construction of the percept. Subjects were 20 adult undergraduate students. A target, designed to indicate the speed of the figure moving behind the slit (assumed speed), proceeded each of the anorthscopically presented figures. The test videotape included 27 randomly ordered anorthscopic displays (three target speeds X three figure speeds X three figures). The dependent variable, attributed length (AL), was based on the length of the figures pointed to in a set of 15 figure alternatives (five lengths for each of the three figures).

A three (target speed) by three (figure speed) by 3 (figure) factorial design was used in analysis. Results showed mean AL at slow target speed ($\underline{M}$=3.03) less than mean AL at medium target speed ($\underline{M}$= 3.44) less than mean AL at the fast target speed ($\underline{M}$=3.86), $p<.01$. In other words, the length of the identified figure increased with each decrease in target speed and decreased with each increase in target speed. These findings supported the hypotheses that anorthscopic perception can be influenced by internal temporal components involved in mentally constructing percepts.

By demonstrating that anorthscopic perception follows a developmental trend similar to Piagetian operations of intelligence, the anorthscopic perception study assisted in validating the perceptual processes involved in mediating the anorthscopic display. The similarity between anorthscopic perception and cognitive imagery skills was further established by the second aspect of the study which found that changes in assumed speed produced analog changes in the constructed percepts.

Questions Pertaining to an Agenda for Research

The media techniques used in the anorthscopic perception study are unlikely to have sufficient impact on imagery ability unless they are part of a more extensive intellectual training program. A comprehensive imagery development program might begin with recognition tasks requiring the identification of figures from successively more abstract depictions. Other strategies might address: cue-attendance, mental rotation (Shepard & Metzler, 1971) anticipatory transformations (e.g., the conservation of liquid task) or anorthscopic perception. More advanced exercises might include tasks which require the perceiver to construct three-dimensional mental representations while viewing a sequence of cross-sections depicting a two-dimensional plane as it travels through objects. A display depicting a two-dimensional plane traveling through the human brain might assist medical students in developing the necessary imagery skills for determining the location and orientation of cortical slices.

Several question pertaining to an agenda for research have arisen:

1). Is further development of schemes for classifying symbol systems and media attributes warranted? Have such schemes relied too heavily on metaphorical comparisons to verbal language (Cassidy & Knowlton, 1983)?

2). Are central mechanisms of perception more "teachable" than affiliated imagery processes because success in perceptual processing requires the immediate construction of percepts?

3). What are the factors that govern the transfer of central perceptual mechanisms to affiliated cognitive imagery processes? What are the factors that hinder transfer?

4). To what extent should media strategies depict imagery transformations? (Some successful computer simulations, such as "The Factory," depict only the before and after state of the objects. The learner must imagine the required transformations).

5). Should media strategies be designed to supplant mental processes or elicit mental processes?

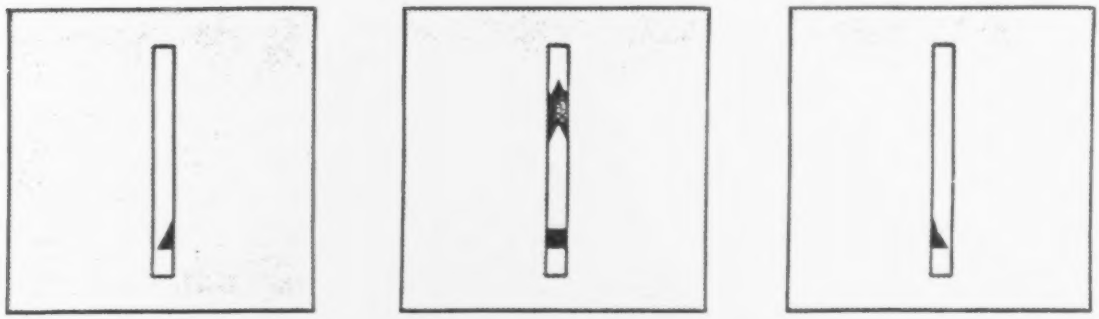
6). What are the essential differences between and among learners which impact on the success of media strategies designed to promote imagery?

7). Is the developmental approach for validating processes affiliated with intelligence sufficient? Are there other, more viable, methods for validating central mechanisms of perception?

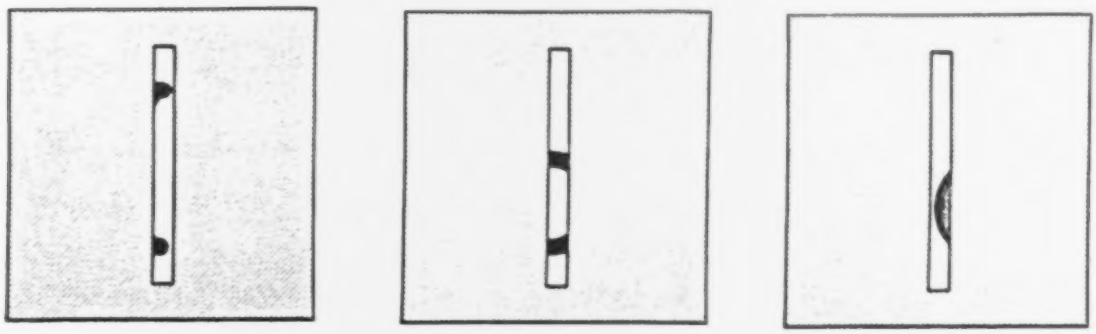
8). How should the media strategies, designed to promote imagery, be organized in a comprehensive intellectual training program? Should a developmental sequence of strategies be established?

Figure 1

The Information Projected at Three Distinct Moments In an Anorthscopic Display



As the familiar equiangular triangle enter the slit, a small right triangle is visible. Half way through the presentation, the apex of the triangle and a small portion of the base are visible. As the triangle leaves the slit, another right triangle is seen. These three features alone may be sufficient for recognition since the viewer has a mental record for "triangle."



The information projected at comparable moments when an unfamiliar figure is presented anorthscopically. In this case the selected revelations may not be sufficient for the viewer to construct a percept of the unfamiliar figure.

References

Aust, R. J. (1984). Mental processes involved in anorthscopic perception. Unpublished doctoral dissertation, University of Washington, Seattle.

Blakemore, C., & Cooper G. F. (1970). Development of the brain depends on the environment. Nature, 228, 477.

Bower, G. H. (1972). Mental imagery and associative learning. In L. W. Gregg (Ed.), Cognition in learning and memory. New York: Wiley.

Brown, E. L., & Deffenbacher, K. (1973). Perception and the senses. New York: Norton.

Bruner, J. S., Olver, R.R, & Greenfield, P.M. (1966). Studies in cognitive growth. New York: John Wiley.

Cassidy, M. F., & Knowlton, J. Q. (1983). Visual literacy: A failed metaphor? Educational Communications and Technology, 31, 67-90.

Clark, R. E. (1983). Reconsidering research on learning from media. Review of Educational Research, 53, 445-459.

Cooper, L. A., & Shepard, R. N. (1970). Transformations on representations of objects in space. In E. C. Corterette, & M. Griedman (Eds.) Handbook of perception. (Vol. 8). New York: Academic Press.

Cornsweet, T. N. (1970). Visual Perception. New York: Academic Press.

Cronbach, L. J., & Snow, R. E. (1977). Aptitudes and instructional methods. New York: Irvington.

Dale, E. (1969). Audio visual methods in technology. (rev. ed.). Scranton, Pa: Dryden Press.

DiVesta, F. J. (1975). Trait-treatment interactions, cognitive processes, and research on communication media. AV Communication Review, 23, 185-196.

Dwyer, F. M. (1970). Exploratory studies in the effectiveness of visual illustrations. AV Communication Review, 18, 235-249.

Dwyer, F. M. (1972). A guide for improving visualized instruction. State College, Pa: Learning Services.

Finke, R. A. (1980). Levels of equivalence in memory and perception. Psychological Review, 25, 43-62.

Flavell, J. H. (1977) Cognitive development. Englewood Cliffs, N.J.: Prentice-Hall.

Flavell, J. H. (1979) Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. American Psychologist, 1979, 34 (10), 906-911.

Fleming, M. L. (1977). The picture in your mind. AV Communication Review, 25. 43-62.

Fleming, M., & Levie W. H. (1984). Instructional message design: Principles from the behavioral sciences. Englewood Cliffs, N.J.: Educational Technology Publications.

Gagnon, D. (1985). Video games and spatial skills: An exploratory study. Educational Communications and Technology, 33, 263-275.
Gibson, J. J. (1954). A theory of pictorial perception. AV Communication Review, 2, 3-32.
Gibson, J. J. (1966). The senses considered as perceptual systems. Boston: Houghton Mifflin.
Gibson, J. J. (1972). A theory of direct visual perception. In J. R. Royce & W. W. Rozenboom (Eds.), The psychology of knowing. New York: Gordon & Breach.
Goodman, N. (1968). Language of art. Indianapolis: Bobbs-Merrill.
Gregory, R. L. (1977). The intelligent eye. New York: McGraw-Hill.
Gyr, J. W. (1972). Perception as reafference and related issues in cognition and epistemology. In J. R. Royce & W. W. Rozeboom (Eds.), The psychology of knowing. New York: Gordon and Breech.
Hadamard, J. (1945). The psychology of invention in the mathematical field. Princeton, N.J.: Princeton University Press.
Heidt, E. U. (1978). Instructional media and the individual learner. New York: Nichols.
Hillgard, E., Atkinson R. C., & Atkinson R. L. (1971). Introduction to psychology. New York: Harcourt, Brace & Jovanovich.
Hochberg, J., & Brooks, V. (1962). Pictorial recognition as an unlearned ability: A study of one child's performance. American Journal of Psychology, 85, 624-628.
Hubel, D. H., & Wiesel, T. N. (1977). Functional architecture of macaque monkey visual cortex, (Ferrier Lecture). Proceeding of the Research Society of London, 198, 1-59.
James, W. (1890). The Principles of Psychology. New York: Holt.
Kaufmann, G. (1979). Visual imagery and its relation to problem solving. Bergen, Norway: Universitetsforlaget.
Kennedy, J. M. (1974). Icons and Information. In D. E. Olson (Ed.), Media and symbols: The forms of expression, communication, and education. (NSSE Yearbook). Chicago: University of Chicago Press.
Kőffka, K. (1935). Principles of Gestalt psychology. New York: Harcourt.
Kőhler, W. (1947). Gestalt psychology. New York: Liveright.
Kosslyn, S. M., & Pomerantz, J. R. (1977). Imagery, propositions, and the form of internal representations. Cognitive Psychology, 9, 52-76.
Lebowitz, H. W. (1965). Visual Perception. New York: Macmillian.

Levie, H. W. (1978). A prospectus for instructional research on visual literacy. Educational Communications and Technology, 26, 25-36.
Movshon, J. A., & Van Sluyters, R. C. (1981). Visual neural development. Annual Review of Psychology, 32, 477-522.
Neisser, U. (1966). Cognitive psychology. New York: Appleton-Century-Croft.
Norberg, K. (1953). Perception research and instructional technology. AV Communication Review, 1, 18-29.
Norberg, K. (1962). Perception research and AV education (introduction). AV Communication Review, 10, (Suppl. 5), 5, 3-9.
Norberg, K. (1966). Perception theory and instructional communications. AV Communication Review, 14, 301-317.
Norberg, K. (1978). Perceptual research: Does it make any difference? Educational Communications and Technology, 26, 5-13.
Olson, D. R., & Bruner, J. S. (1974). Learning through experience and learning through media. In D. R. Olson (Ed.). Media and symbols: The forms of expression, communication, and education. (NSSE Yearbook). Chicago: University of Chicago Press.
Paivio, A. (1976). Images propositions and knowledge. In J. M. Nicholas (Ed.), Images propositions and knowledge. Dordrecht: Reidel.
Piaget, J. (1966a). The mechanisms of perception. New York: Basic Books.
Piaget, J. (1966b). Genetic epistemology. New York: Columbia University Press.
Piaget, J., & Inhelder, B. (1971). Mental imagery in the child. New York: Basic Books.
Richardson, A. (1969). Mental Imagery. New York: Springer.
Rock, I. (1975) An introduction to perception. New York: Macmillian.
Rock, I. (1983). The logic of perception. Cambridge, Mass.: Bradford.
Rohwer, W. D., Jr. (1970). Images and pictures in children's learning: Research results an educational implications. Psychological Bulletin, 73, 393-403.
Salomon, G. (1979). Interaction of media, cognition, and learning. San Francisco: Josey Bass.
Salomon, G. (1981). Communication and education: Social and psychological interactions. Beverly Hills: Sage.
Salomon, G., & Clark, R. E. (1977). Reexamining the methodology of research on media and technology in education. Review of Educational Research, 47, 99-102.
Shepard, R. N., & Metzler, J. (1971). Mental rotation of three-dimensional objects. Science, 171, 701-703.
Shepard, R. N. (1978). Externalization of images and the act of creation. In B. Randhawa & W. E. Coffman (Ed.), Visual learning, thinking and communication, New York: Academic Press.

Shepard, R. N., & Podgorny, P. (1978). Cognitive processes that resemble perceptual processes. In W. K. Estes (Ed.), Handbook of learning and cognitive processes (Vol. 5: Human information processing) Hillsdale, N.J.: Lawrence Erlbaum Associates.

Sternberg, R. J. (1983). Criteria for intellectual skills training. Educational Researcher, 12 (2), 6-12.

Torkelson, G. M. (1977). AVCR - one quarter century: Evolution of theory and research. AV Communication Review, 25, 317-358.

Travers, R. M. W. (1977). Essentials of learning (4th ed.). New York: Macmillian.

Wertheimer, M. (1958). Principles of perceptual organization. In D. C. Beardslee & M. Wertheimer (Eds. and Trans.), Readings in perception. Princeton: Van Nostrand. (Original work published, 1923).

Wundt, W. (1907). Outlines of psychology. Translated by C. H. Judd. New York: Stechert.